

Eco Char	Vital Sign Category	Monitoring Objectives	VS Id#	Vital Sign	Monitoring Question(s)	Monitoring Method	Metrics	Vital Sign Rank (0-5)	Comments / Notes
Biotic Integrity	Landscape	Monitor patterns of distribution & extent of community types	T3	Landscape Fragments, Patch Size, Land Cover	How are the distributions of plant communities and land cover inside and immediately outside the Parks changing over time?	Mapping, repeat photography	FRAGSTAT statistics, Vegetation type	2.6	
		Monitor fire regimes and effect on vegetation	T4	Fire Effects & Dynamics: Vegetation and Landscape Level	What is a natural fire frequency? What changes in plant community composition and structure result from fire? What are the biogeochemical effects of fire?	Transects, plots, histories	change in vegetation structure, Cover, density, erosion, nutrient loss, species composition	2.5	
		Track insect and disease presence during forest dieback	T5	Forest Dieback	What percentage of trees in a populations is declining or dying? What proportion are dying by natural vs. non-native influences? What are temporal trends?	Transects, plots, population surveys	Plant cover, density, vigor, size classes, species composition, Density of herbivores relative to degree of dieback	1.5	
	Community	Monitor community dynamics, structure, function, and composition	T6	Terrestrial Plant Biodiversity	Are there detectable short-term changes in selected native plant communities?	plots, transects	abundance, density, cover, Abundance and trends in selected focal groups of plant species	3.6	
			T7	Long-term Plant Succession	What are long-term trends in plant community composition and structure, regardless of management treatment or land use?	Transects, plots, mapping, remote sensing	Cover, density, vigor, size classes, growth rates, species composition	3.5	
		Monitor effects of management on native communities	T8	Recovery/Change of Native Vegetation with Alien Plant Control	What are trends in plant community composition and structure in response to alien plant control treatments?	Transects, plots	Cover, density, vigor, size classes, species composition, recruitment rates	3.5	
			T9	Recovery/Change of Native Vegetation with Feral Ungulate Control	What are trends in plant community composition and structure after removal or sustained control of feral ungulates? Are habitats damaged by alien ungulate species restorable?	Transects, plots. Monitor fenced areas where ungulates have been removed.	Cover, density, vigor, size classes, species composition	2.4	
			T10	Recovery/Change of Native Vegetation with Invasive Alien Invertebrate Control	Are native plant species recovering where invasive invertebrates are controlled? What are trends in plant community composition and structure following invasive invertebrate control?	Transects, plots	species composition, vigor, size classes, density, Cover, abundance & distribution of alien inverts & native pollinators, flower & seed production	1.8	
	Vegetation	Monitor effects of biocontrol on native and invasive species	T11	Invertebrate Biocontrol of Plants	What is the long-term impact/efficacy on populations of blackberry, passionflower, & other pests? Are non-target plants, especially natives, being affected?	Plots & transects for plants	Infestation rates	1.7	
			T12	Plant Pathogen Biocontrol of Plants	What is the impact/efficacy on populations of control target? Are non-target species being attacked?	Plots & transects	Infestation rates	1.6	
		Monitor population size and distribution of native, endemic, or focal species, including response to restoration efforts. Where appropriate, measure demographics (size/age structure, reproduction, recruitment, etc.) of selected indicator species	T13	Native Plant Species Protection (T, E, S-o-C species)	What are the distribution, abundance, and demographics of threatened, endangered, and rare native plant species? Are plant populations reproducing at self-sustaining levels?	Mapping, plots, counts in size classes	phenology, survival, soil seed bank, population structure, Distribution, density, reproduction	4.0	
			T14	Established Plant Disease & Pathogens	What is the incidence and level of disease in populations? Are diseases/pathogens affecting populations? What are trends in disease/pathogen?			2.9	
			T15	Alien Incipient Plant Disease & Pathogens	Where are disease locations outside parks? What species are they affecting? What are rates and directions of spread? Identify existing disease/pathogen incidence, impact, and trends?			2.6	
		Monitor extent and response to treatment of established invasive species	T16	Established Alien Species - Plants	What is the distribution and abundance of established alien plants? What is the rate of spread of alien plants?	Mapping, transects, plots, counts in size classes	Distribution mapping, frequency	4.0	
		Monitor occurrence of non-established (incipient) invasive species	T17	Alien Incipient Invasive Plants	Is species present, if so what is the nature and extent of infestation? What are the most effective strategies for detecting and preventing new invasives species? Where should efforts be focused? What are potential impacts?	Passive surveillance and follow-up; surveys in high-risk sites (eg. roadsides, trails, ports, disturbed sites)	Presence/ absence, rapid assessment of extent of infestation	3.7	
	Consumers	Monitor occurrence of non-established (incipient) invasive species	T38	Alien Incipient Invasives - Fungi	Is species present, if so what is the nature and extent of infestation? What are the most effective strategies for detecting and preventing new invasives species? Where should efforts be focused? What are potential impacts?	Passive surveillance and follow-up on reports; education, outreach, and public reporting; surveys in high-risk sites	distribution, Presence/ absence, rapid assessment of extent of infestation	2.0	
Freshwater Ecosystems	Producers	Monitor community composition, structure, and productivity	F1	Community dynamics of primary producers	What species & groups are present? What are normal rates of productivity? Where are algal blooms present?	periodic benthic sampling	abundance, distribution, demographics	2.5	

## Intro, Monitoring goals & objectives, Conceptual Models, and Vital Signs

Also use main handout of review materials ([http://www.nature.nps.gov/im/units/pacn/monitoring/plan/vs04/review\\_materials.htm](http://www.nature.nps.gov/im/units/pacn/monitoring/plan/vs04/review_materials.htm))

Ecological Characteristic	Vital Sign Category		Monitoring Objectives
Human activities & cultural practices	Soundscapes		Monitor sound sources, frequencies, occurrence, and levels
	Viewscapes / Lightscapes		Monitor landscape / seascape appearance Monitor light levels and characteristics of light/dark cycles
	Land Use		Monitor points of entry for invasive species Monitor water use adjacent to or upstream from park boundaries Monitor land use adjacent to, or upstream of, park boundaries
	Park Use & Activities		Monitor debris-trash occurrence in coastal, riparian, wetland, and lacustrine habitats; in or near high use areas Monitor patterns of park visitation, use & damage (terrestrial & marine) Monitor incidence & occurrence of bioprospecting
	Management Zones		Monitor levels of take & harvest of harvested species (marine, freshwater, and terrestrial) or resources (coral, sand) Monitor patterns and effects of use and management Monitor effects of management practices on wilderness character
			Monitor visibility Track rates of atmospheric deposition Track atmospheric concentrations of particulates and gases, levels of radiation--emphasizing those with known human health or environmental impacts Monitor core weather/climate conditions within each park (on each island) Monitor frequency and intensity (severity) of extreme events (hurricanes, waves, winds, rain, etc.) Identify and monitor spatial patterns of climate, such as trade-wind inversion elevation, lifting condensation level, lapse rates, etc.
Physical / Chemical Environment	Climate & Air Quality		Monitor physical ocean dynamics--ocean currents, sea level, tides/swell Monitor cycles of nutrients and elements within soils and water--including carbonate (oceanic), nitrogen, and phosphorous Monitor soil erosion Monitor soil quality trends (physical, toxics/contaminants, other biologic and nutrients) Monitor condition and extent of soil crusts Monitor trends in surface water flow regimes Monitor wetland (incl. anchialine ponds) water flow exchange dynamics, size, and distribution Monitor ground water flow rates and direction of movement (recharge)
	Soil, Water, & Nutrient Dynamics		Monitor water quality core parameters Monitor supplemental water quality parameters Monitor microbiological water quality parameters Monitor toxic and contaminant levels in water Monitor biological invertebrate communities
	Water Quality		Monitor surface volcanic activity (lava flows, eruption events & ground deformation) Monitor volcanic & non-volcanic seismicity Monitor extent, location, and causes of mass wasting events (e.g. landslides)
	Geology	Hazards	Monitor shoreline dynamics Track dune locations and topography Identify and monitor the extent of permafrost Monitor karst and non-karst cave and lava tube habitat characteristics, topography, and extent
		Landforms	
Biotic Integrity	Terrestrial Ecosystems	Vegetation	Monitor patterns of distribution & extent of community types Monitor fire regimes and effect on vegetation Track insect and disease presence during forest dieback
			Monitor community dynamics, structure, function, and composition Monitor effects of management on native communities
			Monitor effects of biocontrol on native and invasive species Monitor population size and distribution of native, endemic, or focal species, including response to restoration efforts. Where appropriate, measure demographics (size/age structure, reproduction, recruitment, etc.) of selected indicator species
			Monitor disease incidence and impacts, especially on native species Monitor extent and response to treatment of established invasive species Monitor occurrence of non-established (incipient) invasive species
		Consumers	Monitor community dynamics, structure, function, and composition Monitor effects of management on native communities
			Monitor effects of biocontrol on native and invasive species Monitor population size and distribution of native, endemic, or focal species, including response to restoration efforts. Where appropriate, measure demographics (size/age structure, reproduction, recruitment, etc.) of selected indicator species
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		Cave Systems	Monitor changes in cave communities
		Producers	Monitor community composition, structure, and productivity
	Freshwater Ecosystems	Community	Monitor community dynamics, structure, function, and composition
			Monitor disease incidence and impacts, especially on native species
			Monitor population size and distribution of native, endemic, or focal species, including response to restoration efforts. Where appropriate, measure demographics (size/age structure, reproduction, recruitment, etc.) of selected indicator species
		Population	Monitor extent and response to treatment of established invasive species
			Monitor occurrence of non-established (incipient) invasive species
	Marine Ecosystems	Benthic	Monitor patterns of distribution & extent of community types Monitor community dynamics, structure, function, and composition
			Track community and population trends in harvested fisheries / collected species
			Monitor population size and distribution of native, endemic, or focal species, including response to restoration efforts. Where appropriate, measure demographics (size/age structure, reproduction, recruitment, etc.) of selected indicator species
			Monitor disease incidence and impacts, especially on native species Monitor extent and response to treatment of established invasive species Monitor occurrence of non-established (incipient) invasive species
		Water column (motile)	Monitor community dynamics, structure, function, and composition Track community and population trends in harvested fisheries species
			Monitor disease incidence and impacts, especially on native species Monitor extent and response to treatment of established invasive species Monitor population size and distribution of native, endemic, or focal species, including response to restoration efforts. Where appropriate, measure demographics (size/age structure, reproduction, recruitment, etc.) of selected indicator species
			Monitor occurrence of non-established (incipient) invasive species
			Monitor community dynamics, structure, function, and composition
		Intertidal	Track community and population trends in harvested fisheries collected species
			Monitor population size and distribution of native, endemic, or focal species, including response to restoration efforts. Where appropriate, measure demographics (size/age structure, reproduction, recruitment, etc.) of selected indicator species
			Monitor extent and response to treatment of established invasive species
			Monitor occurrence of non-established (incipient) invasive species